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ABSTRACT

As an aid to increasing teacher effectiveness, this paper outlines findings derived from the field of cognitive psychology on the way in which memory operates, provides examples, and suggests a variety of ways the information can be applied in teaching. Among the findings cited are the following: (1) some types of information can be encoded (i.e., their meaning elucidated) faster than others; (2) information is more easily remembered in the context in which it was first learned; (3) items in the memory are linked together in networks and require "maps" to retrieve them; (4) information that is useful, necessary, or meaningful can be more easily retained than superfluous or irrelevant material; (5) people tend to set criteria to determine whether they understand something; (6) there are limits to short-term memory both in terms of time and capacity; and (7) items in the memory can be activated by recalling related words or concepts. The paper suggests that teachers can apply these findings by, for example, varying the speed at which different types of material are presented; associating concepts with surrounding sights, sounds, feelings, etc.; establishing relationships which link concepts and ideas together; "mapping out" lectures; giving students concrete examples and using mnemonic devices; getting students to test themselves; avoiding overload of the short-term memory; and reactivating students' memories by reviewing facts and concepts. (HB)

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FINDINGS FROM COGNITIVE PSYCHOLOGY AND THEIR APPLICATIONS TO TEACHING

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April 1982

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FINDINGS FROM COGNITIVE PSYCHOLOGY AND THEIR APPLICATIONS TO TEACHING

I. Encoding Time

When people hear a person speaking to them, they must go through a process of encoding (looking up the meaning) of the words they hear. The encoding process takes people time. It is not instantaneous. In some situations people can encode things fast, while they encode more slowly in other situations.

Fast Encoding	Slow Encoding
1. The words and concepts are familiar to the person.	The words and concepts are relatively new to the person.
2. The speaker takes certain information for granted that the listener knows.	The speaker takes information for granted, but the listener does not know it, and is slow to encode the meaning of the sentence.
3. The speaker takes certain information for granted and it is coded on the same level of abstraction. ("Do canaries have feathers?")	The information which the speaker takes for granted is coded on a higher or lower level of abstraction. ("Do canaries have skin?")
4. The speaker's words are spoken at adequate volume and pronounced clearly.	The speaker's words are spoken softly, or distorted (as in an accent), or are ambiguously pronounced (boat or bought).
5. The speaker uses active-voice sentences.	The speaker uses passive-voice sentences. And passive-voice sentences without agent stated produce even slower encoding. Ex.: "The milk was brought to the table." (By whom?)
6. The speaker uses affirmative sentences.	The speaker uses sentences with negatives, and especially double negatives.
7. The speaker uses declarative sentences.	The speaker uses interrogative sentences.
8. The speaker has identified the categories and topics that a statement fits into.	The speaker makes a statement suddenly, out-of-context, and does not identify the category it fits into.

Applications to Effective Teaching:

1. Teachers should vary their speed of talking. Talk at normal speed when giving material in the left column. Talk more slowly when doing things in the right column.
2. When talking in the style that requires students to take longer encoding, it is helpful also (1) to repeat statements, (2) to say them in different ways, and (3) to test for whether the students understood them by asking them questions.
3. Teachers should usually assume that their students will encode material more slowly than they do. Don't be fooled by your own familiarity with the material into talking too fast!

COGNITIVE PSYCH. FINDINGS

II. The Encoding Specificity Phenomenon

At the time a person tries to remember something, the more that the same cues are present that were originally present when the event occurred, then the easier it is for the person to remember it.

On the other hand, if people need to find an item in memory but are in a different context than when the item was learned, they are likely to have difficulty recalling it.

Examples: Your priest in a disco, a student takes an exam in different room than the class was held in, divers learn words underwater and get tested underwater.

This finding applies to seemingly unimportant cues--like the chair you sit on, the smells nearby, the visual appearance of a book, the sight of a teacher's face while giving information, etc. It also applies to other topics learned around the same time. If these cues are present, people remember things faster.

Applications to Effective Teaching:

1. Teachers can help their students learn better by telling them to deliberately make themselves notice the surrounding sights, sounds, feelings, tastes, smells, and the concepts learned at the same time as a certain item.

2. Teachers can suggest that when their students want to recall an item that is hard to retrieve, they should try to remember some of these contextual cues that were present when they learned the item.

3. A teacher can help students to recognize an item in several contexts by teaching it in several intellectual contexts. For example, teach the topic of negative reinforcement on several different days with reference to several other topics. That helps to prevent students from being unable to use a concept in new contexts.

III. Networks of Items in Memory

Cognitive psychologists say that the millions of items in our memories are linked together in criss-crossing networks. It is as though we look down at the towns, cities, and farms of a state from an airplane, and we see the roads--thousands of miles of them--that link up these places. If there's no road to a place, it's hard to get to it, and most people don't bother to visit it. Moreover, if people don't have maps of the roads, it's hard for them to find a place and they may fail to find it. The same goes for memory: You need roads and maps to get thing out of memories.

The concept of a network of items in memory has many implications.

1. If a person puts an item into memory without linking it to the network of other memories, the person is likely to lose the ability to retrieve it. Reciting is good, but not good enough, unless people link new material to old material.

2. It is best to hook an item to a question or to the stimuli which will precede a person's need for that item. The person needs to build a direct path from a question to an answer and to do it when he or she learns the answer.

3. Since a network implies a long series of items linked together, it means that some items are close together and others are far apart. The principle is: The closer items are in a network, the easier it is to start with one and to retrieve the other.

4. If a person learns a "map" of the network of memories at the same time as he or she learns an interrelated set of concepts and facts, the map will help the person retrieve information faster. If a person knows how information is organized, it improves his or her memory search. For example, suppose a student knows that a teacher always gives a concept, a positive example, an "opposite negative example," a verbal definition, and a principle using the concept. Then the student who had forgotten the principle could search for it by thinking of the examples and the definition; they would get the person closer to the principle. Or if a student's map included the knowledge that the teacher always taught a tree leaf's similarities and differences from two or three other leaves, the student could search the memory banks about the other leaves to find the traits of the original leaf.

5. The more that a person consciously builds many paths to an item of knowledge, the more likely the person can recall it later.

6. Here is how people build items into networks: They take two items and think of a relationship between them. And they think of the two, together, united by that relationship. The French Revolution is partly related to the Russian Revolution by <u>similarities</u> in stages. Or people's shared norms and values tend to <u>cause</u> conformity. Or a certain friend's name is related to the shape of her nose.

<u>Application to Effective Teaching:</u>

1. Teachers should provide students with "maps" of their lectures. In other words, organize one's lecture and describe the organization to the students. Also if a teacher knows any unifying patterns to the material, it is helpful to share it with the students.

2. Teachers can suggest that students use mnemonic techniques on complex material in order to impose an artifical organization on it.

3. It is helpful to adopt a few standard patterns of teaching that will help students recognize a familiar path to follow. Be sure to tell the students what the patterns are.

4. Here is an extremely effective network and map method: When one teaches new concepts and gives examples of them and states their technical definition, it is helpful to pick one example that is most typical of the concept. (A prototype.) Then show how the example fits the traits given in the definition. Then tell the students that they should remember the definition by thinking in this sequence: from concept to prototype example to verbal definition. It is often easier for people to start with a word and move to a visual image of an example than to move to a long verbal definition. But when they have recalled an example, they can often inspect the example. Its traits will help them move to the words that make up the definition.

IV. Create A Wanted Empty Category, Pause, and Fill It.

Memory has an emotional drive to it.

If a person has wanted to know something and has been blocked from knowing it for awhile, and then hears it, the person tends to remember it.

On the contrary, if a person is presented with irrelevant and unwanted information, the person tends to forget it.

If a person knows that a certain category of information exists and that it would be useful to know it, the person will pay attention when he or she hears the information. More important, the person will automatically link up the information with that empty category and remember it better.

For example: "Do you want to know what Hilda did last night?" "I have information here on how much of the nation's income the richest 10% of our people earn. Once you know that fact, you'll know how unequal our country is." "I know a secret."

Here is a very important "wanted empty category" to most people: The knowledge that the person lacked when he or she tried to do something and failed. The person's emotional drive to turn a failure into a success makes the missing information very important to know.

Application to Effective Teaching:

1. Teachers can introduce most topics by saying something like this: "I'm going to give you information that answers this question." Then they state the question. Then they delay slightly by detouring a little. Then they give the answer.

2. Teachers can introduce topics by asking people to remember times when they tried something and failed, by giving them a pretest that they fail at, or by having them imagine the future when they might want to know something or do something important to them. Then after the maddening delay, they describe the wanted information that fills the empty category.

V. Memory for Meaningful Material

People can remember information that is meaningful to them much better than meaningless information.

By the word "meaningful" I mean that the person can easily encode it into pictures, sounds, feelings and experiences. "Meaningful" also means that the person can relate it to other information. For example, the new information is bigger or smaller, a cause, an effect, a change, a uniquely different event than others in its category and so on.

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Words and sentences that people can picture or turn into stories are usually more meaningful than abstract words and numerical data. But experts in a field find even abstractions and numbers to be meaningful because they have lots to compare them with.

Applications to Effective Teaching:

1. When teachers teach new material to their students, they can try to make it meaningful.

2. They can provide good, concrete examples for each abstract concept, and they can remind the students to think of some examples in order to make the abstractions meaningful.

3. They can teach the students how to use mnemonic devices (visual encoding, the link, the story mnemonic). Mnemonics give an artificial meaning to abstract meaningful material. It helps students get through the early difficult phases of learning a new subject.

4. Teachers should remember that they find the material more meaningful than their students do, simply because they have thought through its relationship to other things. They must not be fooled by the illusion that "Because I understand the meaning and significance of these ideas, therefore my students also find it meaningful. . . Or else they are willful coarse pigs." Teachers should help their students find the meaning in abstract new material. By doing so, they will increase students' memories and, incidentally, make it more fun.

VI. Standards and Self-Tests

People tend to act until they have produced results that match the standards they have set for themselves.

People make constant little tests to see if their results match the standards. Comparing results to standards equals a test.

The higher the standards they have set, the longer they will continue working.

If people have specific criteria which tell them when they understand something, they will work harder and understand it better than if they lack criteria.

Applications to Effective Teaching:

1. When teachers give lectures, they can tell their students how to test themselves so they can know whether they understand the material. They should say something like this: "Here's how you can tell if you're getting what is important from this talk." Then the teacher lists the criteria.

2. It is also useful to list the criteria negatively-- to say, "Here's how to tell if you have missed something." Then list the danger signals.

3. Usually, teachers cite understanding and note-taking on X number of concepts, facts, general principles, a chain of reasoning that proves something, noticing evidence and its relationship to a theory, a set of how-to-do-it steps, and so on.

4. Here is what happens if a teacher does NOT define the criteria for a self-test: The students will usually apply the self-test of "Did I feel I understood the meaning of the teacher's words?" They will listen to the lecture in the sequence in which it is given and be content with understanding. However, if they should have noticed seven general principles, they will miss them because they were mixed with examples and other material. They won't mentally notice and highlight the really important material. If students are not told to use a certain standard, they will usually lapse into passive listening. And passive listening fails to produce either a good understanding of key concepts or good memory.

5. Teachers should tell students to ask them questions if they find by their self-tests that they are not getting the important thing. Or teachers can refer them to pages in a book. Or to a certain way to practice. Teachers should always give students some way to fix it up when they don't get what they're supposed to. If students lack a way to make up a deficiency, they'll feel despair and will often withdraw psychologically from the class.

VII. Short-Term Memory Has Time Limits and Capacity Limits

1. When people see or hear information, they can retain it in their short-term memories without rehearsal for about 15 to 20 seconds. It begins to fade rapidly shortly after it is heard. (Example: People quickly forget telephone numbers, names of new acquaintances, specific facts in a lecture.)

2. People's short-term memories have an average capacity for about seven bits of information, plus or minus two. If they are asked to store more, the new items will overload the memory and some information will be lost.

3. When people hear teachers lecture, the new information goes into their short-term memories. If they think about the information and connect it to other items, they can transfer it into long-term memory. But if they do not think about it and continue listening to additional information from the lecture, this new information faces two dangers: (1) fading quickly and (2) not getting in or staying in because of overload.

Applications to Effective Teaching:

1. Teachers should try to prevent overloading their students' short-term memories with too much new material. They can help their students by giving them constant brief reminders of the meaning of concepts, facts, and principles they have previously taught.

2. When teachers introduce new material, they can do it at a controlled pace, slow enough for students to think it over and to begin to make connections with other material in the long-term memory. Teachers can also stimulate their students' process of making connections to long-term memory by linking it to examples and other previously known material.

3. Teachers should assume that many students have forgotten earlier new material. They can provide repetition and brief reminders.

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Short-term memory (cont'd)

4. Teachers should teach their students the facts about the short-term memory. Many students do not understand how quickly they will forget. They mistakenly believe that it is enough to understand a lecture and that they will automatically remember it. They need to be told to take notes. They need to be told to think over the material in such a way that they link it to related material in their long-term memories.

5. Teachers can increase the students' memory capacity of seven bits of information by organizing information into unified chunks, each of whose parts is a new bit of information. Teach several things, then unify them into a chunk by showing a pattern that unifies them. Teach several more things and create a new chunk. Then unify the two chunks. And so on.

VIII. Activating A Memory Network

When a person thinks of an item in memory, it increases the person's speed of recalling other items which exist near it in memory. And when a person thinks of several items, it helps the person have easier access to a whole cluster of related memories. That is called "speed of activation."

It is as though the person sent energy to a memory and the energy warmed up additional memory locations nearby. Many people have returned to a task they left behind a few days ago and felt cold, distant, and confused about it. Yet they started work on it. As they remind themselves of facts about the task, they feel themselves mentally warming up and swarms of facts come back.

Applications to Effective Teaching:

1. As teachers start a lecture, they can activate students' memories by briefly reviewing a few concepts, facts, and ideas from past classes. That will pay off for the students with better understanding and better memories.

2. Teachers should remember that their memories for the subject are usually more activated than their students' memories. It does not mean the students are dumb. It's a normal happening and can be corrected by a brief warmup period at the start of class.

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April 1982

SOME GOOD BOOKS ON COGNITIVE PSYCHOLOGY

John R. Anderson, Cognitive Psychology and Its Implications. San Francisco: W.H. Freeman, 1980. A textbook, but well-written and friendly and clear.

Morton Hunt, The Universe Within: A New Science Explores the Human Mind. New York: Simon and Schuster, 1982. A popularly written book, interesting, useful. Less technical.

Roy Lachman, Janet L. Lachman, and Earl C. Butterfield, Cognitive Psychology and Information Processing: An Introduction. Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1979. The most thorough textbook; must be read while awake!

Kenneth L. Higbee, Your Memory: How It Works and How to Improve It. Englewood Cliffs, N.J.: Prentice-Hall, 1977. A thorough little gem on memory and mnemonic techniques.

Richard L. Bandler and John Grinder, Frogs into Princes.
Box F, Moab, Utah: Real People Press, 1979.
Transcripts from workshops conducted by the authors. An introduction to the fascinating field of neuro-linguistic programming. A combination of linguistics, psycho-therapy, computer programming and other fields. Worth reading.

Richard L Bandler and John Grinder, Trance-formations.
Box F, Moab, Utah: Real People Press, 1981.
More transcripts from workshops, this time on how to do hypnosis and how to use it to help people. Very helpful. Fascinating.

Many more books in this area exist for the interested reader.

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